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Nanotechnology used in treatment of hepatocellular carcinoma (HCC)

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ABSTRACT

Nanotechnology literally means any technology on a nanoscale that has applications in the real world .This technology in treatment , imaging and drug delivery for human cells.

Several studies have reported nanotechnology in the field of medicine and in treating various kinds of diseases such as cancer.

This report will discuss the role of this tiny materials in treatment of hepatocellular carcinoma(HCC) and will study its hazards.

INTRODUCTION

Nanotechnology can be defined as the science and engineering involved in the structure ,synthesis ,characterization and application of materials and devices. A nanometer is one billionth of a meter or three sets of size smaller at that point a micron ,generally the size of an atom itself (e,g. a DNA atom is about 2.5 nm long while a sodium molecule is about 0.2 nm(1) .

The properties of materials at the nanoscale can be totally different from those at a larger scale . when the dimension of a material is decreased from an enormous size , the properties remain the same at first , then small changes happen , until finally when the size drops below 100 nm , dramatic changes in properties can happen(2) .

For clarity , the term "nanotechnology" is used to define supramolecular assemblies of several to several hundered nanometers for therapeutic (also called " nanomedicine" (3) .

Nanomedicienes are generally assembled using phospholipids (i,e.liposomes) , polymers (i,e.nanoparticles or micelles) , or iron base materials (i,e.ultra small iron oxide nanoparticles "USPIO" (3) .

For application to medicine and physiology ,these materials and devices can be intended to communicate with cells and tissues at a molecular level with a high level of functional specificity , thus permitting a degree of integration between technology and biological systems. nanotechnology has been considered for improved delivery of various therapeutic agents , including drugs and genes with ability to minimized the side effects of other medications(1) .

In this report, we will discuss the role of nanoparticles in a treatment of hepatocellular carcinoma (HCC) (is the most primary malignancy of the liver in adults and the third most common cause of death from cancer worldwide , related to the prevalence of hepatitis B virus infection , drug use and other causes of hepatic cirrhosis) and its hazards . in several uses cases , treatment of HCC is complicated due to multiple pathologies , despite the availability of various options such as liver transplantation , surgical resection , and radiofrequncey ablation and transarterial chemoembolization (3) .

One of the main reasons for HCC failure in chemotherapy is its chemoresistance against various antitumor factors. Furthermore, the oral or intravenous injection of chemotherapy are aften insufficient at the tumor site. increase the concentration of drugs in the hepatic tissue , where the HCC tumor is located , prolonging exposure of tumor tissue to treatment , and thus addressing the chemoresistance issue was thought to contribute to therapeutic improvement , while at the same reducing side effects by reducing the concentration of drugs in healthy tissues .some of the nanomedicines have achieved a plausible clinical success so far (3).

AIM OF STUDY

To clarify the role of nanoparticles to treat hepatocellular carcinoma (HCC) and studying its hazards.

Material and methods

The report was performed to discover studies reviewing the role of nanotechnology in treatment of hepatocellular carcinoma . online sites included in this report are pubmed and google scholar . search terms included " nanotechnology in treatment of liver cancer" " introduction to nanotechnology " " introduction to nanotechnology and its application to medicine" " disadvantages of nanotechnology " .

RESULTS

This report talks about two drugs (Polymeric nanoparticles , Thermosensitive liposome "Thermodox") equipped with nanotechnology , which is one of the best techniques for treating cancers in all parts of the body with less damage than other drugs .

During our study and research about nanotechnology , we concluded that the main reason for using the nanotechnology drugs is that they directly targeting the effected area , because they have the ability to recognize to the a specific receptor on the surface of tumor cells, and they do not harm any healthy cells.

Despite all these features and fame reached by nanotechnology , it has many negative aspects that are still under research . as it has many effects on the heart , lungs and others on both the patient and the therapist and also effects on the environment .

DISCUSSION

The role of nanoparticles in treating hepatocellular carcinoma

(i) Polymeric nanoparticles: doxorubicin transdrug (DT) is a doxorubicin loaded poly(isohexyl cyanoacrylate) nanoparticle formulation that showed considerable antitumor activity against multidrug-resistant protein-overexpressing hepatocellular carcinoma in vivo model . This nanomedicine is currently under in HCC patients, single dose 40 mg/m2 intra-arterial hepatic injection was found to be the MTD of DT, and was accompanied by major toxicities, such as grade-4 neutropenia, pseudo-allergic reactions, and acute respiratory distress syndrome, while 35 mg/ m2 was considered to be the dose with acceptable safety. In a recent phase II trial that compared the efficacy of DT (30 mg/m2 repeated doses) versus the current standard of care (transarterial chemoembolisation with a cytotoxic drug), 88.9% survival rate was observed after 18 months of DT treatment against only 54.5% survival rate in patients treated with the current standard of care, while similar toxic events as observed during phase I study were the major side-effects(3).

Another nanoparticle that has been tested in clinic (phase II) is Mitoxantrone-loaded Polybutylcyanacrylate (PBCA) nanoparticle i.v. formulation. This treatment showed a slight improvement in efficacy with a 2.2 month higher median survival time, a 10.5% objective response rate (ORR) versus no ORR in free mitoxantrone-treated group, and also an improved safety, as compared to free mitoxantrone It would be. interesting to see if this slight efficacy improvement argues for further clinical development of this formulation(3).

(ii) Thermosensitive liposome (Thermodox) (in conjunction with hyperthermia): this drug delivery concept is based on the injection of a liposomal formulation made of lysophospholipids which decreased the phase transition temperature of the liposomal membrane down to 39–40 _C. After specific tumor extravasation of liposomes, the heating of the diseased tissue may trigger drug release from the liposomes This approach has been successfully applied to the anticancer compound doxorubicin and has resulted in higher local drug concentrations and hence considerably higher antitumor activity, in an in vivo xenografted model, compared to non-thermosensitive liposomes . Apart from being cytotoxic, Thermodox caused the shutdown of tumor blood flow and thus acted as an antivascular agent too, creating damage to the deeper tumor tissue. In a phase I study, Thermodox (30 mg/m2) in conjunction with radiofrequency ablation (RFA) showed improved safety with mild alopecia and neutropenia, and absence of cardiotoxicity, renal toxicity, and hand–foot syndrome which was previously observed in a considerable patient population treated with poly(ethylene glycol)-liposomal doxorubicin. with RFA, in patients suffering from A phase III trial of Thermodox in conjunction non-resectable hepatocellular carcinoma(3).

In addition to the above, approaches such as magnetic fluid hyperthermia (heating the magnetic nanoparticles using an externally-applied alternating magnetic field) combined with pharmacotherapy by employing drug-loaded polymer –coated magnetite nanoparticles, and homing device- mediated active targeting (by targeting asialoglycoprotein receptors overexpressed on hepatic cells) using galactosylated polymeric nanoparticles have been attempted for hepatic tumor treatment in preclinical models, with reasonable success(3) .

In the former case, carboplatin was non-covalently encapsulated into chitosan and then coated onto the magnetic nanoparticles to provide a sustained drug release. These intra-arterially injected nanoparticles were guided to the transplanted liver tumor in mice, which was then subjected to hyperthermia; a superior antitumor efficacy (tumor weight inhibition ratio of 93% and prolonged survival to the antitumor activity in the absence of hyperthermia. In the latter case, low molecular weight chitosan nanoparticles surface-modified with galactose residues were non-covalently loaded with doxorubicin. These nanoparticles were demonstrated to be taken up by hepatic cells through the asialoglycoprotein receptor in vitro, whereas no proof-of-concept has been done in vivo. Gene delivery has also been attempted for the treatment of liver tumors. For instance, antihuman bcl-2 siRNA complexed with cationic liposomes (composed of 2-O-(2-diethylaminoethyl)-carbamoyl-1,3-O-dioleoylglycerol and egg phosphatidylcholine) resulted in a significant reduction of liver model, as opposed to free siRNA(3).

The hazards of nanoparticles

Nanotechnology also has increased health danger, nanoparticles due to their small size may trigger inhalation issues and many other fetal diseases and may easily harm the lungs by just inhaling for 60 seconds in the air . Nowadays, nanotechnology is very expensive and can cost a lot of money to create(4).

Nanotechnology has boosted living standards but also increased emissions. For living organisms this form of contamination is very harmful. Nanoparticles ' drawback is very poorly discussed. So there are only a few more drug delivery-based ones. Development of nanoparticles for drugs that provide comprehensive detergent use of polyvinyl alcohol as detergent that create an issue on toxicity(4).

Nanoparticles have limited targeting capacities, which is why it is not possible to discontinue therapy. Nanoparticles drug delivery reveals cytotoxicity, alveolar inflammation. Disruption of autonomic dysfunction by nanoparticles having direct effect on cardiac function and vascular function. Nanoparticles show particle formation, unpredictable freezing pattern, expected polymer transmission dynamics and sometimes burst release(4).

Conclusion

In conclusion , nanotechnology considered as one of the most famous techniques medical field to treat various types of cancers in recent years and it can reduce the side effects of other medication (i,e.chemotherapy) .

Therefore , this report introduced a simple introduction about nanoparticles and its role in the treatment of hepatocellular carcinoma , and studying its hazards.

REFRENCES

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